

Developments to minimize marine mammal exposure to wind farm construction noise

Dr Ursula Verfuss, SMRU Consulting, University of St Andrews, UK

*NYSERDA workshop: The State of the Science on Wildlife and Offshore Wind Energy Development
13th/14th November 2018, New York*



SMRU Consulting

Europe • North America • Asia Pacific

Introduction

Offshore wind farms

- Monopiles and jackets are dominant foundations
 - Standard installation method: Impact pile driving
 - Noise increases with pile diameter and hammer energy
- Impact on marine mammals
 - Auditory injury
 - Behavioral reaction
- Impact assessment
 - Determination of impact area based on noise level thresholds
- Strategies to minimize noise impact



SMRU Consulting

Europe • North America • Asia Pacific

Mitigation strategies

- Exclusion zone (mitigation zone, safety zone)
- Acoustic deterrent devices
- Soft start (ramp up)
- Seasonal / spatial restrictions
- Noise reduction/thresholds
- Low noise installation methods and foundations



Kerryinlondon, Flickr



SMRU Consulting

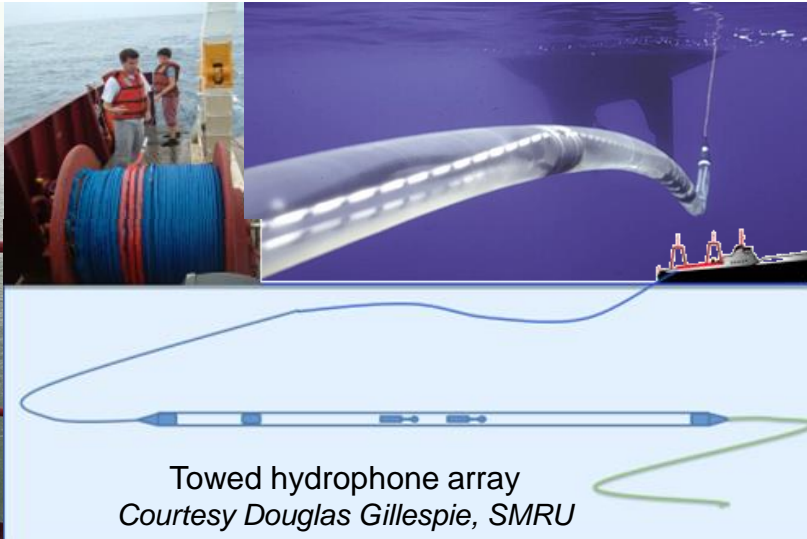
Europe • North America • Asia Pacific

Exclusion zone

- Aim: No animal within impact area upon start of piling to minimize risk of auditory injury
- Marine mammal monitoring
 - Visual observation by Marine Mammal Observers (MMOs)
 - Passive acoustic monitoring with towed or stationary hydrophones



Marine Mammal Obs
Courtesy Lindsay Porter,
SMRU Consulting HK



Towed hydrophone array
Courtesy Douglas Gillespie, SMRU



Coastal Acoustic Buoy

Courtesy Jason Wood, SMRU
Consulting NA



SMRU Consulting

Europe • North America • Asia Pacific

Exclusion zone

Limitations

- May miss animals present in impact area
 - Detection efficiency should be high, which depends on
 - Area covered by monitoring
 - Environmental conditions (waves, fog)
 - Species specific factors (size, dive duration)
 - Detection range must cover impact area
- May result in delays to piling

Marine Pollution Bulletin 126 (2018) 1–18



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul



Review

Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys

Ursula K. Verfuss^{a,*}, Douglas Gillespie^b, Jonathan Gordon^c, Tiago A. Marques^{d,1},
Brienne Miller^{e,2}, Rachael Plunkett^a, James A. Theriault^f, Dominic J. Tollit^e,
Daniel P. Zitterbart^{g,3}, Philippe Hubert^h, Len Thomas^d



SMRU Consulting

Europe • North America • Asia Pacific

Acoustic deterrent devices

- Aim: No animal within impact area upon start of piling to minimize risk of auditory injury
- Emission of deterrent sounds for 15+ minutes before start of piling to deter animals away from construction site
 - Variety of brands, models with different acoustic characteristics
 - *See Sparling et al. (2015). ORJIP report.*
 - *McGarry et al. (2018). JNCC report 615*



SMRU Consulting
understand • assess • mitigate



JNCC Report
No: 615



Guide for the Selection and Deployment of Acoustic Deterrent Devices

**ORJIP Project 4, Stage 1 of Phase 2:
The use of Acoustic Deterrents for the mitigation of
injury to marine mammals during pile driving for
offshore wind farm construction.
Final Report**

McGarry, T., de Silva, R., Canning, S., Mendes, S., Prior, A., Stephenson, S.
& Wilson, J.

July 2018



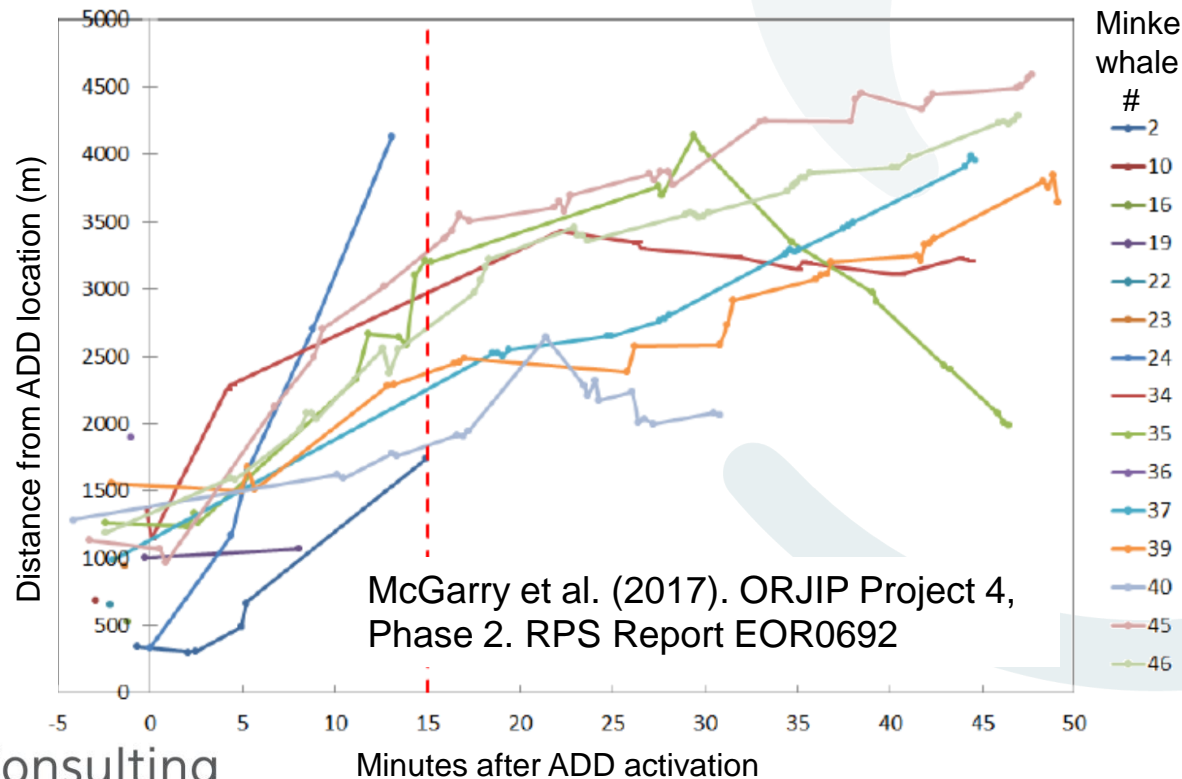
SMRU Consulting
Europe • North America • Asia Pacific

THIS REPORT IS TO BE CITED AS: SPARLING¹, C., SAMS², C., STEPHENSON, S²., JOY³, R., WOOD⁴, J., GORDON⁵, J., THOMPSON⁶, D., PLUNKETT⁷, R., MILLER⁸, B. & GÖTZ³, T. (2015). THE USE OF ACOUSTIC DETERRENTS FOR THE MITIGATION OF INJURY TO MARINE

Acoustic deterrent devices

Limitations

- Response specific to species / individual and device used: e.g. Lofitech:
 - Minke whale (McGarry et al. 2017),
 - Harbor porpoise deterred to a min of 7.5 km (Brandt et al. 2013)

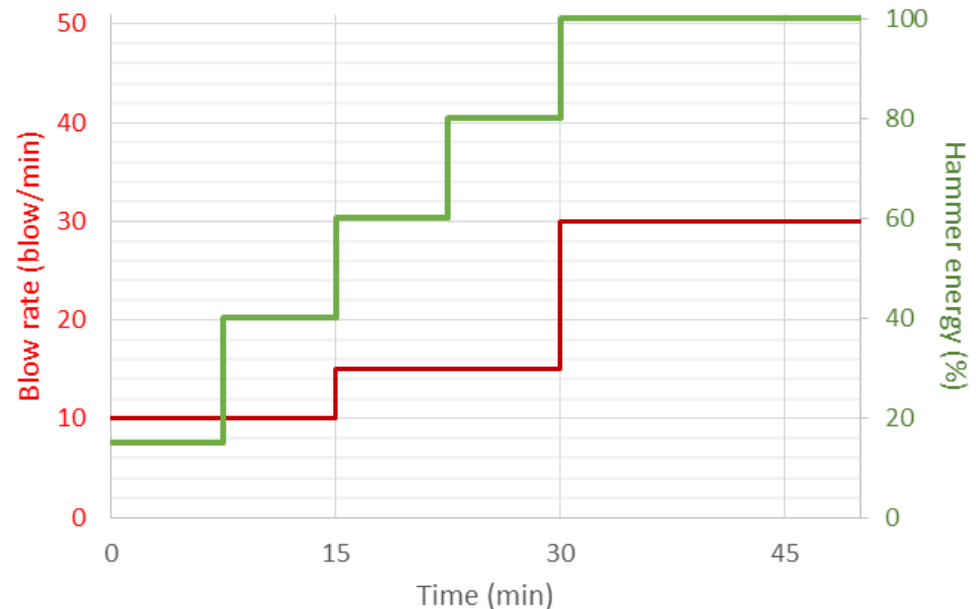


SMRU Consulting

Europe • North America • Asia Pacific

Soft start

- Aim: Deterring the animals away from construction side to minimize risk of auditory injury.
- Piling starts with low („soft“) hammer energy and low blow rates, then gradually increases to maximum energy and blow rate
- Reduces the sound energy a fleeing animal is exposed to
 - Smaller impact areas for risk of PTS due to cumulative sound exposure level (SELcum)
- “Design” of soft start: tool to reduce risk of PTS



SMRU Consulting

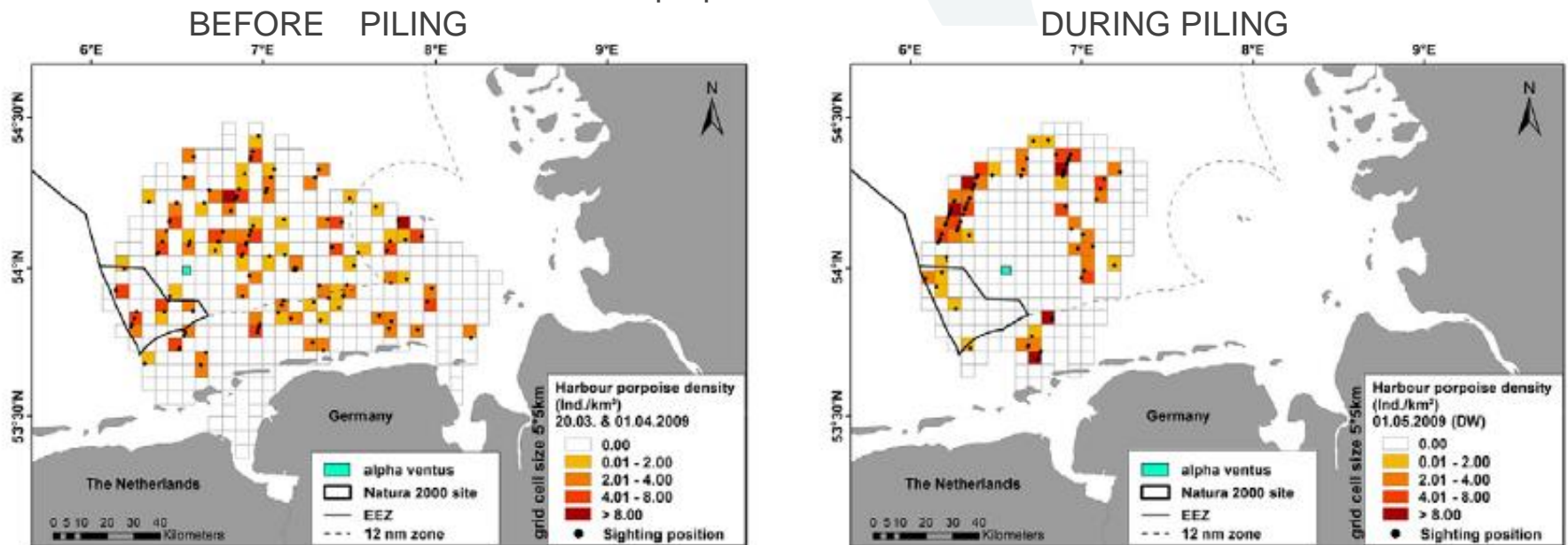
Europe • North America • Asia Pacific

Soft start

Limitation

- Design of soft start must be suitable for hammer
- May still result in reasonable impact ranges for auditory injury
- Animals may not react to pile driving

Harbour porpoise distribution



Dähne et al. (2013). Env. Res. Lett. 8



SMRU Consulting

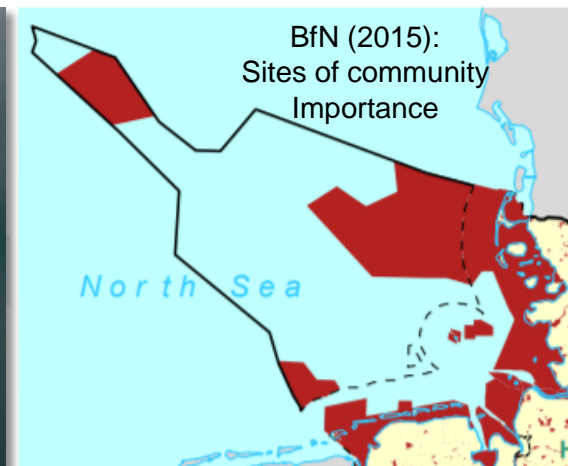
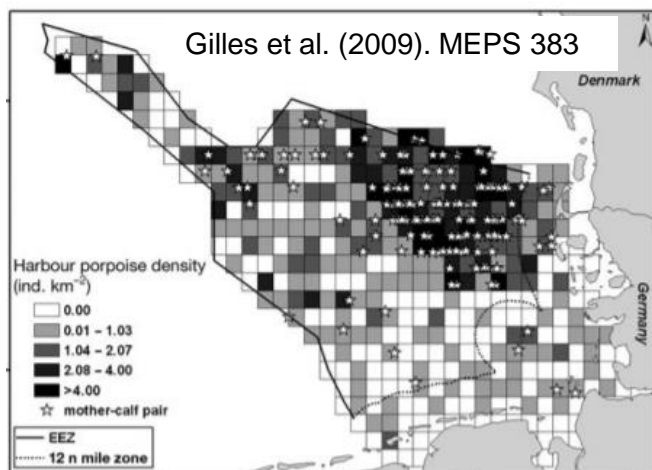
Europe • North America • Asia Pacific

Seasonal / spatial restrictions

- Aim: Limitation of impact during sensitive periods / in important areas
- Limitations in construction during sensible time / in important areas
 - Periods / areas with high animal density
 - During breeding or mating periods / in breeding or mating areas

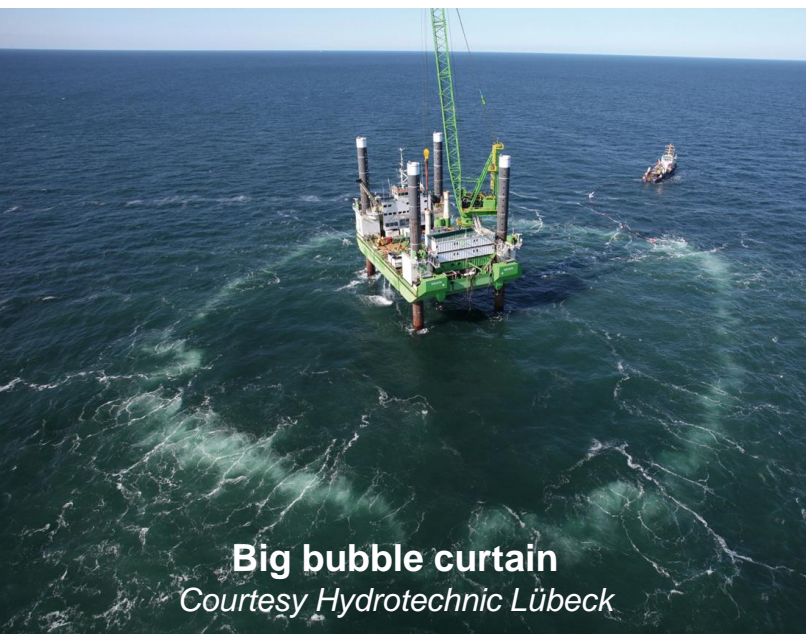
Limitations

- Periods or area of high animal density may change over time
- Sensitive times may shift
- Might affect feasibility of Offshore wind farm projects



Noise reduction

- Aim: Reduction of noise levels transmitted through the water column
- Use of noise abatement systems for pile driving, e.g.
 - Big bubble curtain (BBC)
 - Isolation casings (IHC-NMS)
 - Resonator (HSD)



Big bubble curtain
Courtesy Hydrotechnik Lübeck



IHC Noise mitigation screen (NMS)
Courtesy IHC-IQIP



Hydrosound damper (HSD)
*Courtesy Daniel Weihrauch,
OffNoise-HSD-Systems GmbH*



Noise reduction

- Aim: Reduction of noise levels transmitted through the water column
- Use of noise abatement systems for impact pile driving, e.g.
 - Big bubble curtain (BBC)
 - Isolation casings (IHC-NMS)
 - Resonator (HSD)

System	Influencing factor	Reduction in SEL
BBC	Supplied air volume, Diameter & length of nozzle hose, Hole configuration of nozzle hose, Air feed-in (one or double-sided), Ballast chain position (inside/outside)	10 to 15 dB
IHC-NMS	Space between inner and outer tube, Additional BBC inside	10 to 14 dB
HSD	Number and size of HSD elements	8 to 13 dB
<i>Adapted from Bellmann (2014). Inter-Noise.</i>		



Noise reduction

Limitations

- Environmental limitations (e.g. water depth, current)
- Efficiency may be frequency dependent
- Higher logistical effort (increased costs)

Number of deployments during pile installations at different water depths

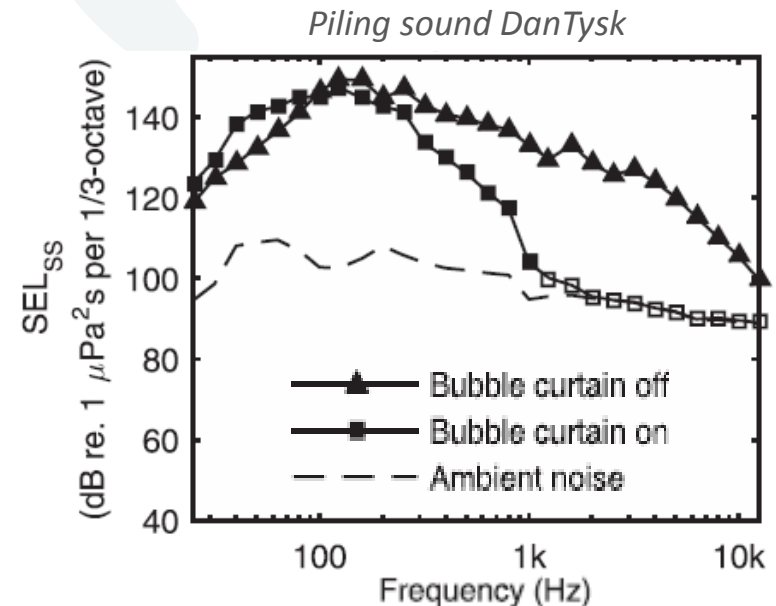
Water depth	BBC	Casing	HSD
< 20 m	~ 80	~ 70	1
– 30 m	> 500	> 230	~ 140
– 40 m	> 400	> 100	~ 90
> 40 m	~ 50	-	~ 20

Adapted from F. Thomsen & Verfuss, T. (in press). In: M. Perrow (ed.)
Offshore: Monitoring and Mitigation. No. 4. Pelagic Publishing.

LOOK OUT for

“A review of noise abatement systems [...] and the potential for their application in Scottish waters”

Commissioned by Scottish Natural Heritage



Tougaard & Dähne (2017). JASA Express Letters



SMRU Consulting

Europe • North America • Asia Pacific

Low noise solutions

- Aim: Generating less noise during construction
- Use of alternatives to impact piling
 - Vibratory piling
 - BLUE piling
- Use of low noise foundations
 - Gravity base foundations
 - Suction buckets
 - Floating foundations

Limitations:

- Environmental limitations
- Different logistical requirements
- Potential change in impact



SMRU Consulting

Europe • North America • Asia Pacific



BLUE Hammer
Courtesy Carbon Trust
Michael Stephenson



Suction bucket @ AOWF
Courtesy Vattenfall / Tobias Verfuss

Comparative summary

- Aim of mitigation measure: Mostly minimising risk of auditory injury
- Some also reduce risk of behavioural impact
- More effective solutions may have higher cost implications and influence on construction schedule

	Exclusion zone	Acoustic deterrent	Seasonal / spatial restriction	Soft start	Noise reduction	Low noise foundation
Auditory impact	↓	↓	↓	↓	↓	↓
Behavioral impact	=	↑	↓	↓	↓	↓
Cost implications	↑	↑	↑	↑	↑	↓↑
Logistical requirements	↑	↑	↑	↑	↑	↓↑



SMRU Consulting

Europe • North America • Asia Pacific

Conclusion

Noise mitigation strategies

- Should be tailored to specific projects / habitat / species
 - Adaptive management
- Do not necessarily reduce behavioral impact
- Strategies focusing on mitigating auditory injury:
 - Better understanding / improvement of detection efficiency (monitoring)
 - Better understanding of displacement efficiency (ADD)
- Noise reduction strategies:
 - Potential trade-off: Spatially reduced vs temporally increased disturbance
- Careful evaluation of potential change in impact



SMRU Consulting

Europe • North America • Asia Pacific

Thank you for your attention

Kerryinlondon, Flickr

We have an ear for you!

Get in touch with us at:

info@smruconsulting.com

Europe: +44 (0)1334 464 746

Canada: +1 (604) 737-7678

USA: +1 (360) 370-5493

Asia Pacific: +852 3428 3873

ukv@smruconsulting.com



SMRU Consulting

Europe • North America • Asia Pacific